Welcome

Participants of Training Program on Disaster Preparation and Mitigation Strategies in Urban areas

CREATING DISASTER RESILIENT WATER UTILITY

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Water Utility ??

- Drinking Water Supply Systems
- Waste Water Systems
- Storm Water Systems

Utilities encounter many challenges related to aging infrastructure, natural hazards, etc.

DISASTERS

- Earthquake Hazards
- Wind Hazards
- Floods Hazards
- Land Slides Hazards

Resilient

Strong enough to deal with any outside extra forces/pressures/stresses

Extra forces due to:

Earthquake

High velocity winds/storms

Floods

Push by land mass due to land slide

Resilience

Resilience is broadly the capacity of an utility to prepare for disruption, to recover from shocks and stresses, and to adapt and grow from a disruptive event.

Building the Resilience of Water Supply and Sanitation Utilities to Threats can be done in phases.

Building the Resilience of Water Supply and Sanitation Utilities is a three-phase process:

Phase 1:

Knowing the system.

The process starts with participatory work to identify the vulnerable and critical elements of the system; the potential threats to those elements and the consequences of their individual or joint failure; the utility's performance objectives; and available solutions.

Phase 2:

Identifying vulnerabilities.

The water system should be stress-tested in a range of plausible hypothetical scenarios to assess its likely performance. The analysis is done first on the system as it is and then repeated on the system enhanced by a variety of resilience building solutions. Performance is measured against the objectives defined in Phase 1. Analysts identify options that reduce vulnerability and improve the performance of the system and its critical elements under the same hypothetical scenarios.

Phase 3:

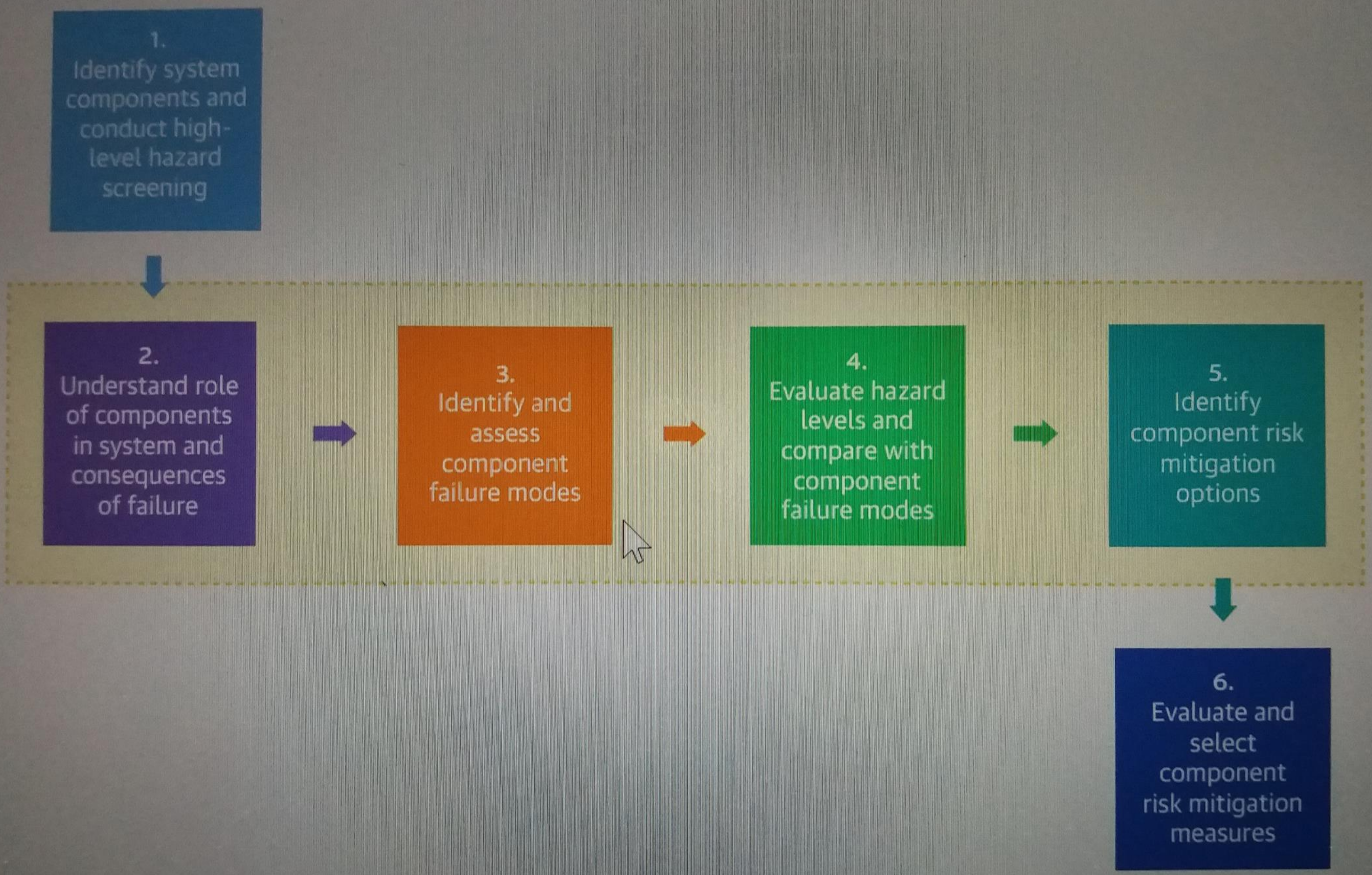
Choosing actions

Analysts organize the options into robust and flexible strategies. The options should include careful monitoring for conditions in which the system departs from acceptable performance.

The Principles of Resilient Design

The basic approach to resilient design is illustrated in figure in the next slide. The process is intended to guide engineers and utility managers in the selection of measures to boost infrastructure resilience by addressing the following key questions:

- **What are the consequences of component failure?**
- **At what hazard level is the component vulnerable to failure?**
- **What is the potential range of hazard levels?**
- **What are the cost and level of protections by risk mitigation measures ?**
- **What residual risk exists after incorporating risk mitigation measures and what can be done should this risk materialize??**


1. Identify system components and conduct high-level hazard screening
2. Understand role of components in system and consequences of failure
3. Identify and assess component failure modes
4. Evaluate hazard levels and compare with component failure modes
5. Identify component risk mitigation options
6. Evaluate and select component risk mitigation measures

Six Steps to Resilient Infrastructure

Step 1. Identify System Components and Conduct High-Level Hazard Screening

What are the components of the water system? Are the components in locations subject to flooding, earthquake, or high winds?

Step 2. Understand the Role of Each Component in the System and the Consequences of Failure.

How does each component affect the functioning of the system? What happens to the system if the component fails?

Step 3. Identify and Assess Component Failure Modes.

What are the vulnerabilities of a component that would lead to failure should a Flood, Earthquake , or High-Wind event occur?

Step 4. Evaluate Hazard Levels and Compare Them with Component Failure Modes?

Can a potential hazard reach a level of severity such that it would cause a given component to fail?

Step 5. Identify Component Risk Mitigation Options

What design options are available to reduce the chances that a component would fail should one of the hazards reach a level that triggers a failure mode?

Step 6. Evaluate and Select Component Risk-Mitigation Measures.

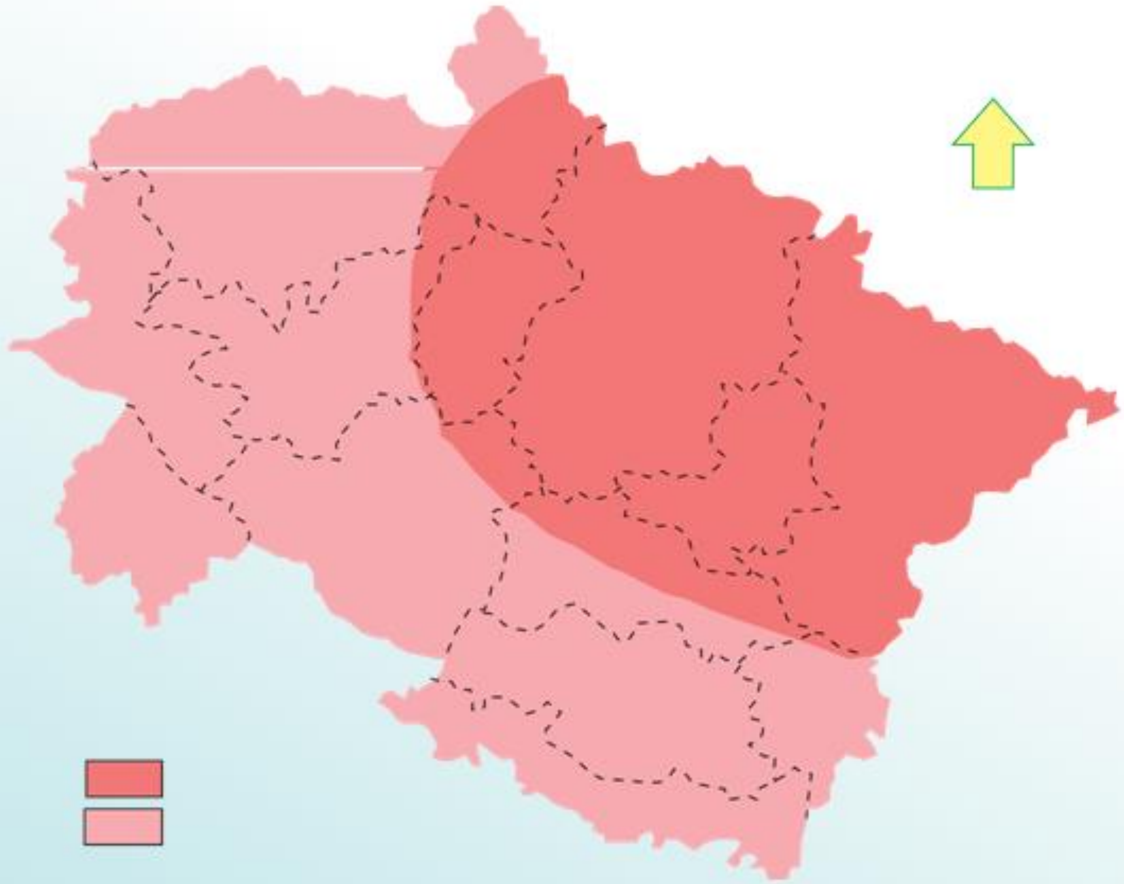
Of the options available to mitigate the risk of failure, what are the options that can be selected that comply with the proposed objectives and take into account existing constraints?

How does one arrive at this decision? After deciding upon which risk mitigation measures to implement, what are the residual risks and what can be done should these risks materialize?

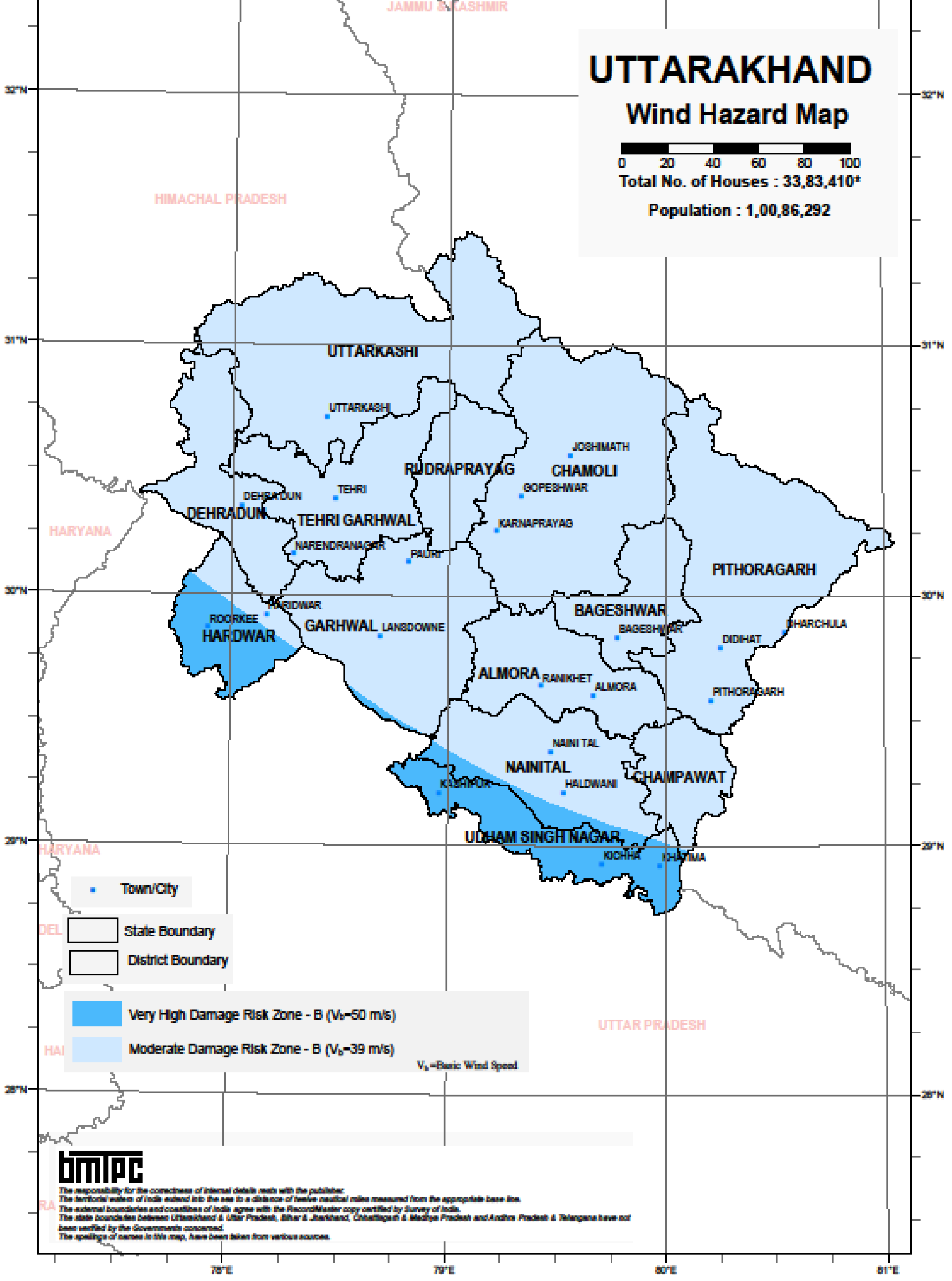
Understanding Vulnerability

As shown in the map, four of the thirteen districts of the State (Pithoragarh, Chamoli, Bageshwar and Rudraprayag) entirely fall in Zone V (representing damage risk of equal or more than IX on MSK scale), whereas other five districts (Uttarkashi, Tehri-Garhwal, Pauri, Almora and Champawat) fall partially in Zone IV and partially in Zone V (damage risk of VIII on MSK scale) and the rest (Dehradun, Haridwar, Nainital and Udham Singh Nagar) fall in the Zone IV of earthquake risk levels.

UTTARAKHAND EARTHQUAKE ZONATION

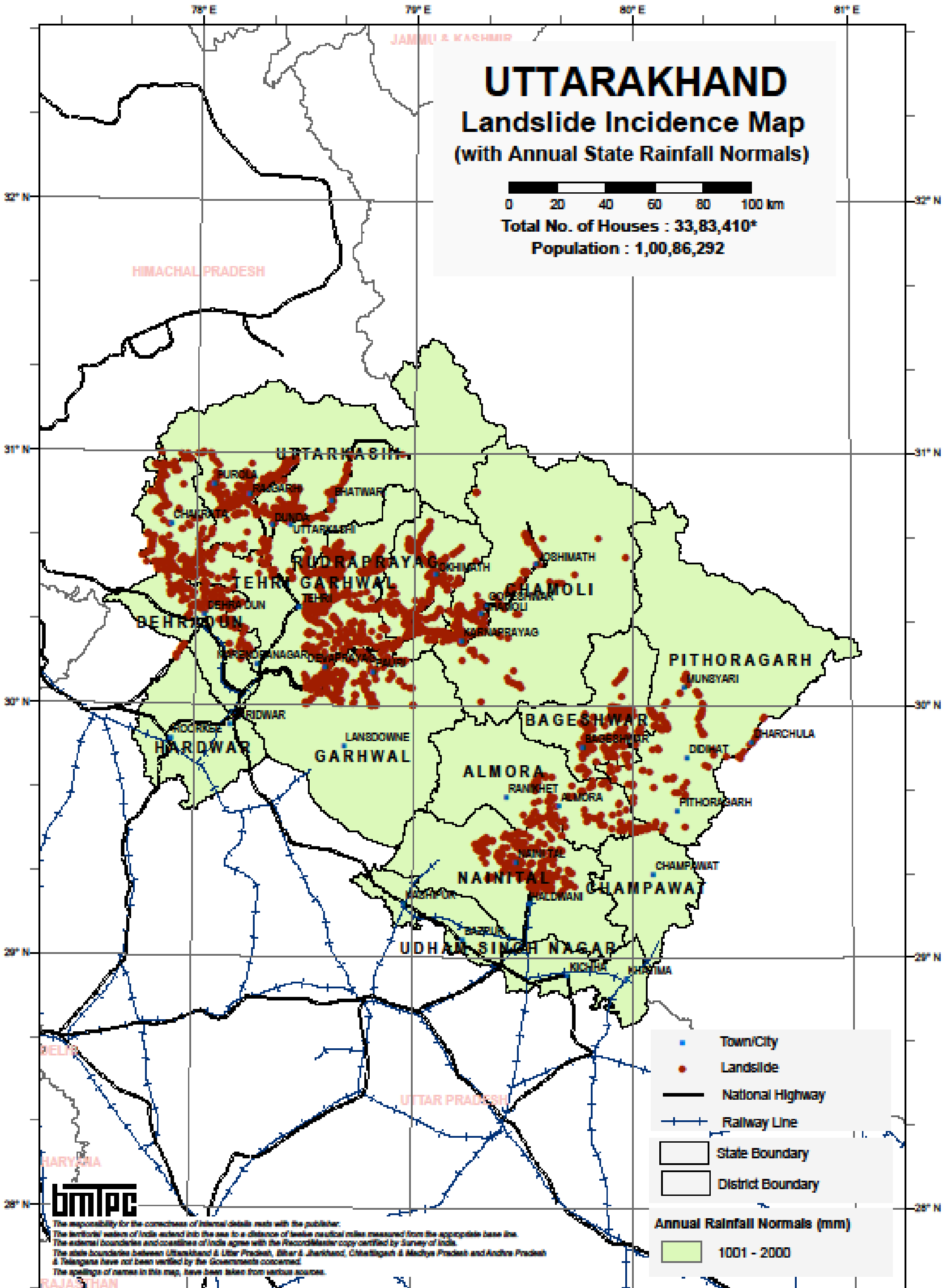


District Udhamsingh Nagar and District Haridwar (mostly) fall in high damage risk zone. The basic wind velocity in this area is around 50 m/s. Other districts fall in moderate risk zone, where the basic wind velocity is around 39m/s.



BMTPC: Vulnerability Atlas - 3rd Edition; Peer Group, MoHUA; Map is Based on digitised data of SOI, GOI; Basic Wind Speed Map National Building Code 2016, Houses/Population as per Census 2011; *Houses including vacant & locked houses. Disclaimer: The maps are solely for

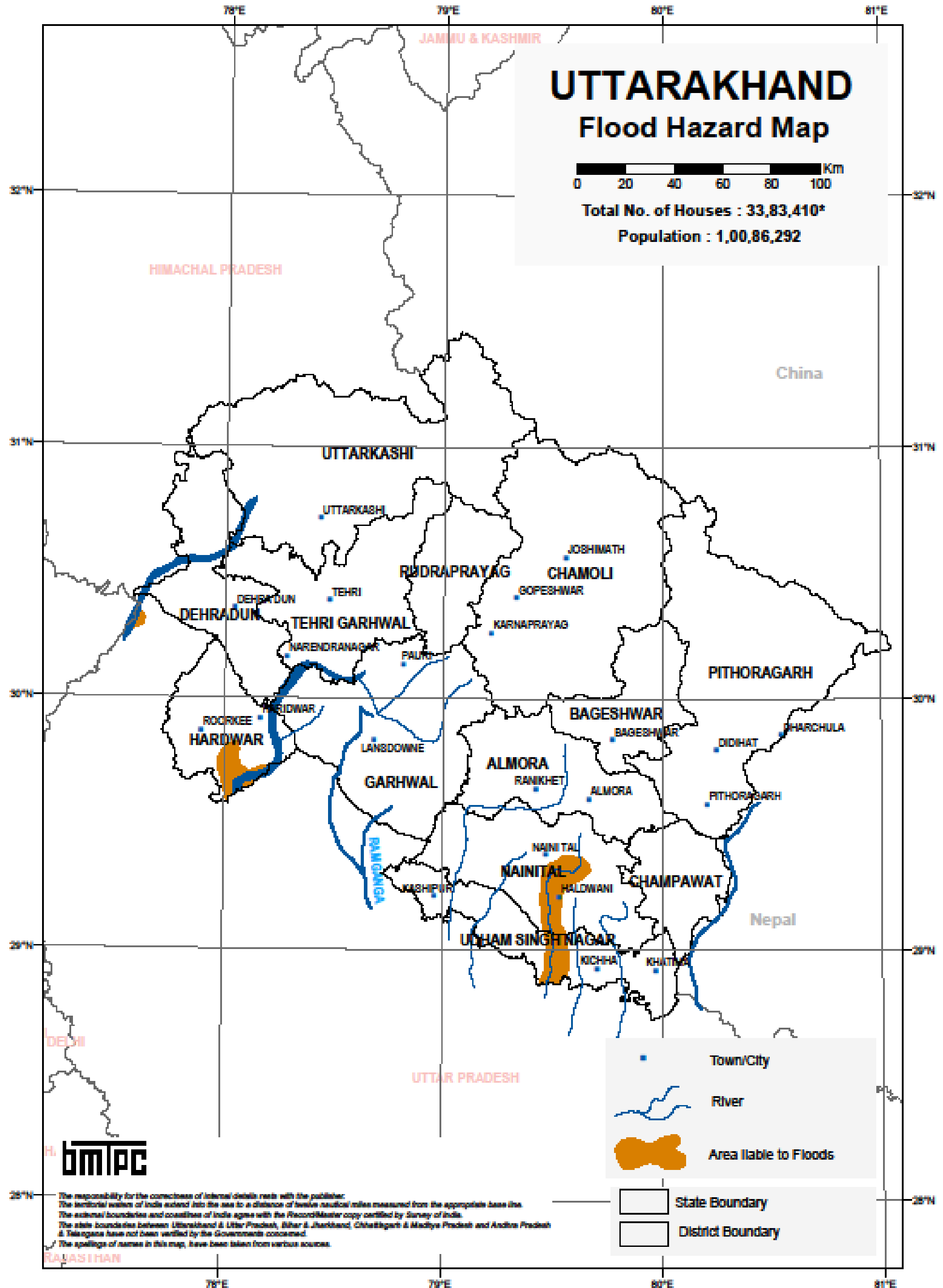
In 2013, because of heavy rain due to cloud burst there were flood hazards and soil erosion and flood induced land Slides. Considerable damages happened. Urban infrastructure in 41 out of total 75 towns was seriously affected by flash floods. Scouring and heavy deposition of silt caused damage to intake wells and treatment plants of the water supply schemes in the mountainous districts of Chamoli, Rudraprayag, Pauri, Tehri, and Uttarkashi



As a result, about 1,12,000 people were directly affected in terms of reduced coverage of municipal water supply systems. Almost 50 raw water intake stations and tube wells and 40 km of pipelines were severely damaged in this incident.

In Rural areas of 9 districts except Udhamsingh Nagar, Haridwar, Nainital and Pauri 340 water supply schemes were fully damaged, additionally 2363 water supply schemes were partially damaged.

About 930 household toilets were washed away in the five worst affected districts, including 893 soak pits and 14,526 meters of drains. In the other eight less affected districts, about 2,408 toilets, 2,435 soak pits and 27,244 meters of drains were washed away.



As per MoUD, Building Material and Technology Promotion Council's Vulnerability Atlas, 2019 a few districts have been shown flood prone district without mass Land Slides. (Ref. Map shown on the left).

Vulnerability of System Components to Damage

Tables

Types of Flood Damage to Components of Drinking Water Systems

Components	Physical damage
Intakes	Debris and excessive sediment can clog river intakes. These can suffer severe damage due to impact from debris or collapse due to erosion around supporting structures.
Wells	Floodwaters can overtop wellheads, causing damage to the casings and contaminating the well water. Shallow wells can be contaminated even if the wellhead itself has not been overtopped.
Water treatment plants	Floodwaters can wash out open tanks and filter beds, damage mechanical equipment and electrical power and controls, contaminate the treatment process and water storage, and strew debris on the site. Floods can also alter sourcewater chemistry and increase turbidity, requiring more demanding treatment and time. Inundated buildings are often badly damaged.
Chemical and fuel storage tanks	Floating debris can puncture above-ground tanks and damage their foundations. Floating tanks can break free of their anchoring and spill their contents. Without chemicals or fuels, services could be disrupted for a prolonged period.

Types of Flood Damage to Components of Drinking Water Systems

Components	Physical damage
Water storage tanks	Tanks can be damaged by the force of floodwaters.
Pump stations	Floodwaters can damage pumps. Dry wells can become inundated.
Electrical controls and instrumentati on	Damage to or loss of these systems can affect operations (e.g., treatment processes and pumping) and data collection in operational centers and treatment plants, for example
Drinking-water distribution networks	Piping and appurtenances (e.g., fire hydrants, valves, and stream crossings) can suffer impacts from debris or be washed out by fast-flowing floodwater. Distribution lines from groundwater wells could be similarly affected and could also become contaminated by floodwaters
Power Supply	Floods often result in power outages that can affect or shut down a treatment plant or its components. Floodwaters can enter backup generators and render them useless.

Types of Flood Damage to Components of Wastewater Systems

Components	Physical damage
Wastewater collection networks	Sewers can be clogged or physically damaged or experience additional infiltration and inflow during a flood. Sewage can back up and flood streets, houses, and businesses.
Lift stations	Sewage can back up, flooding houses, businesses, farmland, and roadways.
Wastewater treatment plant	Floods cause increased flows to the plant due to inflow and infiltration; introduce contaminants into treatment processes and disrupt bioreactors; wash out primary and secondary clarifiers, aeration tanks, and chlorine contact chambers; and interfere with biosolids' handling and disposal. Sewage can back up and overflow into streets, houses, and businesses in case of headwork failure. Buildings can be inundated by sewage
Chemical and fuel storage tanks	Floating debris can puncture above-ground tanks and damage foundations. Floating tanks can break free of their anchoring and move with floodwaters while spilling their contents. Without chemicals or fuels, service could be disrupted for a prolonged period.

Types of Flood Damage to Components of Wastewater Systems

Components	Physical damage
Electrical controls and instrumentation	Loss of these systems can impact operations (e.g., treatment processes and pumping) and data collection in operational centers and treatment plants.
Power Supply	Floods often cause power outages that can affect or shut down a treatment plant. Floodwaters can enter backup generators and render them useless.
Treated waste water outfalls	Floodwaters can submerge and clog outfalls with debris or sediment and erode their foundations. Clogged outfalls can cause sewer backups

Vulnerability of High/Strong Wind

Types of Wind Damage to Components of Drinking Water Systems

Components	Physical damage
Intakes	There can be damage from concurrent flooding.
Wells	Well heads damaged by airborne debris.
Water treatment plants	Inundation of open tanks and filter beds; broken mechanical equipment for electrical power and controls, contaminated treatment processes and water storage, on-site debris. Destroyed buildings. Restricted access to facilities because of debris and damaged roads.
Chemical and fuel storage tanks	Airborne debris can puncture above-ground tanks and damage their foundations. Tanks can break free of their anchors and spill their contents. Without chemicals or fuels; prolonged service disruptions are possible.

Types of Wind Damage to Components of Drinking Water Systems

Components	Physical damage
Water storage tanks	Strong wind can exerts pressure on body of tank and thus un-stability of whole structure and airborne debris can puncture elevated storage tanks .
Pump stations	Above ground appurtenances can be damaged by airborne debris..
Electrical controls and instrumentati on	Control buildings can be damaged by wind- or airborne debris. The loss of systems housed in these buildings can disrupt operations (e.g., treatment processes and pumping) and data collection in operational centers and treatment plants.
Drinking-water distribution networks	Networks can also be damaged if nearby buildings are destroyed.
Power Supply	Power outages can damage or shut down a treatment plant or its components. Airborne debris can damage backup generators.

Types of Wind Damage to Components of Wastewater Systems

Components	Physical damage
Wastewater collection networks	Collateral damage from the collapse of nearby buildings.
Lift stations	Collateral damage from the collapse of nearby buildings..
Wastewater treatment plant	Wind may blow out primary and secondary clarifiers, aeration tanks, and chlorine contact chambers.
Chemical and fuel storage tanks	Punctured above-ground tanks; damaged tank foundations. Tanks that break free from their anchors can spill their contents. Prolonged service disruptions

Types of Wind Damage to Components of Wastewater Systems

Components	Physical damage
Electrical controls and instrumentation	Control buildings can be damaged by wind- or airborne debris. The loss of systems housed in these buildings can affect operations (e.g., treatment processes and pumping) and data collection in operational centers and treatment plants.
Power Supply	Power outages can shut down treatment plants and their components. Airborne debris can damage backup generators or render them useless
Treated wastewater outfalls	Damage can result from concurrent flooding (see Table 1).

Earthquake affects all the structures.

All type of water retaining structures are affected badly as the water in the tank also exerts impulsive and convective forces due to vibration .

Earthquake and high/strong Wind forces resilient elevated reservoirs be designed considering full of water and empty to mitigate the effect of Earthquake and Wind.

For design of Liquid Retaining Structures- I S : 3370 (Part-1 and Part 2): 2009

For design of Staging of OHSR/ESR- I S : 11682 : 1985 (R2003)

For Earthquake Resistant Structures- I S: 1893 Part-1: 2016

For Earthquake Resistant Structures- I S: 1893 Part-2: 2014

The foundations of these structures are designed as per the IS: 2950(Part-I) 1981 with latest amendments for the Raft foundation and IS: 2911-1979 for Pile Foundations.

For Wind Loads on Structures- I S : 875 (Part 3): 1987

For Snow loads on structures- I S : : 875 (Part 4): 1987

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2. Disaster Management in India, 2011, Ministry of Home Affairs, GoI, New Delhi
3. EPA- United States Environmental Protection Agency: Creating Resilient Water Utilities (CRWU); Resilient Strategies Guide
4. EPA: (i) Water Resilience; (ii) Effective Utility Management Practices; (iii) Sustainable Water Infrastructure
5. World Bank Group, Global Practice Working Paper, Resilient water Infrastructure Design Brief
6. National Institute of Disaster Management, Uttarakhand Disaster 2013, Ministry of Home Affairs, GoI, New Delhi, 2015

Thanks for your participation and patience hearing